PATENT SPECIFICATION

624,939

Convention Date (Switzerland): July 12, 1946.

Application Date (in United Kingdom): July 14, 1947. No. 18707/47.

Complete Specification Accepted: June 20, 1949.

Index at acceptance:—Class 51(i), A1b1, B27a.

COMPLETE SPECIFICATION

Gas Turbine Combustion Chamber

We, AKTIENGESELLSCHAFT BROWN, BOVERI & CIE., of Baden Switzerland, a Swiss Company, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The combustion chambers of gas turbines have an extremely high heat loading, which considerably exceeds the value which is generally considered to be the allowable limit for the combustion chambers of steam boilers. Gas turbine combustion chambers have therefore to be well cooled if they are to attain a sufficiently long life. This can be achieved if an internal element *a*, as shown in Figure 1, is inserted, the inner surface of which is in contact with the flame, whilst its outer surface is subjected to a stream of air which cools it. With combustion chambers having a very high loading and which are required to have a long life, even such a measure is inadequate, and the internal element has to be provided with a ceramic lining. With very high temperatures this protective ceramic lining will, however, be attacked by the slag from the fuel and thus eventually be destroyed.

For steam boilers it is known to line the combustion chamber with water tubes *b*, as shown in Figure 2, to which pins *c* are welded for supporting the ceramic mass *d*. The purpose of the pins *c* is, however, not only to support the ceramic mass but also to conduct heat away from the latter to the water-cooled tubes *b* and thus cool the ceramic mass.

This method of cooling is much less effective when used in combustion chambers for gas turbines, because in this case there is no water available for cooling purposes and hot air has to be used, with the result that the transfer of heat from the wall of element *a* to the air is much lower than when the tubes are water-cooled. The result is that the ceramic mass, from which too little heat is conducted away through the pins, attains a much higher temperature than when water-cooled tubes are present and is therefore much more liable to become destroyed.

A considerable improvement can, however, be achieved in this respect when in accordance with the present invention the pins provided for supporting the ceramic lining of gas turbine combustion chambers are so constructed that they are subjected to a stream of cooling air which cools them directly.

Several constructional examples of the invention are illustrated in Figures 3 to 13 of the accompanying drawings.

Figure 3 shows a gas turbine combustion chamber in longitudinal section.

Figures 4 and 5 are an internal view and longitudinal section of part of the combustion chamber of Figure 3, drawn to a larger scale.

Figures 6 and 7 show a longitudinal section and a cross section respectively of a combustion chamber embodying a modified form of the invention.

Figures 8 and 9 show another modified form of the invention, also in longitudinal and cross sectional views.

Figures 10 to 13 show further partial sectional views illustrating other solutions in accordance with the invention.

In Figures 3 to 13 reference letter *c* again indicates the pins which are welded to the internal element *a* and serve to support the ceramic mass *d* lining the element *a*. These pins *c* as shown in Figures 3 to 12, extend through element *a* into the space *e* through which cooling air flows. The air which enters the combustion chamber at *f* (Figures 1 and 3) divides into two streams, namely the combustion air stream for the burner *g* with the swirling device *h* and the cooling air stream which flows through the space *e*, whereby in the case of the construction shown in Figures 3 to 12 the external surface of the pins *c* is in contact with the cooling air stream and is thus directly cooled. By this means not only is the heat transfer surface greatly increased, but also the effectiveness of this surface greatly

improved, due to the pins *c* which project into the cooling space *e* causing a turbulence in the cooling air which greatly assists the heat transfer and thus also the cooling effect.

The pins *c* can also be provided with vanes *i* or fins *k* as shown in Figures 6, 7 and 8, 9 respectively, so as to increase the cooling surface still further.

The pins *c* must be of a non-scaling material because on the hot gas side they attain very high temperatures. The heat conductivity of the pins can be improved by making them hollow and filling the hollow space with a material which is a good heat conductor, such as aluminium or copper (Figure 10). Even if this material should melt during service, this does not matter as long as the hollow space is totally enclosed. By this means it is possible to improve still further the cooling of the pins *c* and the ceramic lining *d*.

The cooling effect can be still further improved if, as indicated in Figure 11, the hollow pins *c* are filled with a material which evaporates at the temperature prevailing at the hot end of the pins and condenses at the cold end, whereby the heat transfer from the hot to the cold side is increased. Such a material is sodium, this being used for similar purposes in the valves of the internal combustion engines. In this case the pins must be inclined as shown in Figure 11 so that the vapour produced at the hot end flows from the inside to the outside and in an upward direction, whilst the condensed material flows back again to the inside due to its greater weight.

A very simple way of improving the cooling of the pins *c* is indicated in Figures 12 and 13. In this case the pins are constructed as tubes which are open at both ends so that the cooling air can flow through them. With such an arrangement it is necessary that the pressure in the space *e* surrounding the element *a* should be somewhat higher than the pressure inside the element *a*. In most cases this is naturally so because a pressure drop occurs in the burner *g* (Figure 3) which results in a pressure difference between the outside and inside of the element *a*, this pressure difference being adequate to maintain a flow of cooling air through the pins.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Gas turbine combustion chamber with an internal element the inner surface of which is in contact with the flame and the outer surface of which is cooled with air, characterised by the feature that said element is lined with a ceramic mass which is supported by pins which are so constructed that they are subjected to a flow of cooling air and thus cooled directly.

2. Gas turbine combustion chamber as in Claim 1, characterised by the feature that the pins which support the ceramic mass penetrate the wall of the element and project into the part of the combustion chamber through which cooling air flows.

3. Gas turbine combustion chamber as in Claims 1 and 2, characterised by the feature that the part of the pins which project beyond the wall of the element are provided with means which increase their cooling surface.

4. Gas turbine combustion chamber as in Claims 1 and 2, characterised by the feature that the pins are hollow and filled with a good heat-conducting material.

5. Gas turbine combustion chamber as in Claims 1, 2 and 4, characterised by the feature that the hollow pins are filled with a medium which evaporates at the temperature prevailing at the hot end of the pins and condenses at the cold end, for the purpose of increasing the heat transmission from the hot to the cold end.

6. Gas turbine combustion chamber as in Claim 1, characterised by the feature that the pins are constructed in the form of tubes so that cooling air can flow freely through said tubes from the space surrounding the internal element to the space inside said element and in contact with the flame, whereby the pins are more effectively cooled.

7. Gas turbine combustion chambers substantially as herein described.

8. Gas turbine combustion chambers substantially as illustrated in any of Figures 3 to 13 of the accompanying diagrammatic drawings.

Dated this 14th day of July, 1947.

MARKS & CLERK.

Leamington Spa: Printed for His Majesty's Stationery Office by the Courier Press.—1949.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies, price 2s. 0d. each (inland) 2s. 1d. (abroad) may be obtained.

[This Drawing is a reproduction of the Original on a reduced scale.]